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A characterization of the drivers, pressures, ecosystem functions and services of Namatala wetland, Uganda

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ABSTRACT

Namatala wetland near the town of Mbale in the Eastern region of Uganda is a papyrus wetland that is subject to conversion for agriculture (mainly rice farming) and pollution by wastewater. The main goal of this study was to analyze the ecosystem functions and services of Namatala wetland and their drivers of change, and to suggest directions for sustainable use. Data on climate, hydrology, water quality, population and land use were collected. Stakeholder workshops were organized at national and local levels to identify stakeholder interests in the wetland and conflicts. The institutional context for management of Namatala wetland was analyzed. A qualitative assessment of the ecosystem services was performed. All results were integrated into a DPSIR network showing the drivers of change, impact on ecosystem services and possible responses for management. Results show that the communities around Namatala wetland strongly depend on the wetland ecosystem for provisioning services. A spatial gradient in ecosystem services was observed. The upper, converted part of the wetland is more important for provisioning services while the lower, more intact wetland supports regulating and habitat ecosystem services. The institutional framework is complex due to the involvement of several ministries at the national level and several levels of decentralized, local government. Horizontal and vertical coordination of policy implementation is weak. There are diverging perceptions among stakeholders about the priority issues in wetland management. Resource users worry about water and land use conflicts, while local and national government agencies are more concerned about agricultural encroachment and biodiversity loss. There are also differences in interpretation of land ownership between the national wetland policy and local customary arrangements. For sustainable management of Namatala wetland, there is a need for more horizontal and vertical coordination in wetland policy implementation, application of sustainable agriculture and integrated water and nutrient management techniques, and continued monitoring, research and capacity building to support adaptive management.

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1. Introduction

The relationship between wetlands and riparian communities is determined by their ecosystem services. This was emphasized by the Millennium Ecosystem Assessment (MEA, 2005), which highlighted the provisioning, regulating, cultural and supporting ecosystem services of wetlands. Uganda is endowed with abundant wetland resources ranging from grass swamps, mountain bogs and seasonal flood plains to swamp forests. These rich resources serve an estimated 2.7 million people with water, fish, construction materials, food crops and livestock grazing (WMD/MWE/UBOS/ILRI/WRI, 2009). In addition, wetlands are important for regulating services such as nutrient retention, wastewater treatment, flood control, and water storage (IUCN, 2005).

Despite the important services they provide, wetlands in Uganda face severe degradation caused by a range of pressures. Like in other areas of sub-Saharan Africa (e.g., Wood, 2003; van Dam et al., 2011) the main pressures are population growth, agricultural development and urbanization (NEMA, 2006/2007; Hartter and Southworth, 2009). The immediate economic benefits from agriculture are accompanied by the loss of hydrological and water quality functions and of biodiversity. The direct productive value of wetlands was estimated at 300–600 US\$/ha/y while the value of non-marketed regulating services, such as water purification and carbon sequestration, was estimated at 10,000 US\$/ha/y (WMD/MWE/UBOS/ILRI/WRI, 2009). The overall benefits are much higher when all ecosystem services are balanced so that not one single category is developed at the cost of another. However, achieving this is a challenge given the current information deficiencies on wetland functions and services, the inadequate planning systems, and the policy conflicts and institutional weaknesses associated with wetland planning and management (Maltby, 2009).

Over the past 20 years, Uganda has developed one of the most advanced wetland policy frameworks in Africa. A major step was the development of the Wetlands Policy in 1995. Subsequently, strategies concentrated on building an institutional framework to enable sectoral integration of the multiple agencies dealing with wetland issues, mainly at the national level. At the community level, the current strategy is to involve local actors in developing community-based management plans for the key wetlands (IUCN, 2005). This is part of a wider policy of decentralization of natural resources management to the districts and local councils led by the Ministry of Local Government (Bakema and Iyango, 2001).

Despite this well-developed policy framework, wetland degradation is still widespread. An example is the Namatala wetland near the town of Mbale in the east of Uganda, a wetland under pressure of agricultural development, domestic and industrial pollution, and harvesting of vegetation and other wetland products. In such a wetland, a balance between the provisioning and regulating services is necessary to achieve sustainable management. The main goal of this paper is to analyze the ecosystem functions, services and the drivers of change in Namatala wetland and to suggest directions for sustainable use. The specific objectives were to: (1) describe the present Namatala

wetland system; (2) analyze wetland stakeholder characteristics and management institutions; (3) assess ecosystem functions and services; (4) analyze the key drivers, pressures and their impact on the ecosystem services; (5) identify potential policy and management responses that can promote balanced exploitation of ecosystem services in Namatala wetland. This research was done as part of the EU-funded FP7 WETwin project (www.wetwin.net; Zsuffa et al., 2008).

2. Research background and methods

2.1. Study area description

Namatala wetland has an approximate size of 260 km² and is shared administratively between Mbale, Butaleja, and Budaka districts. Its catchment includes the districts of Sironko, Pallisa, Manafwa, Tororo and Bududa (Fig. 1). The wetland lies in the lowlands of Mbale district between 1082 and 1128 m altitude and is fed by streams arising from the Mbale plain and the Mount Elgon highland zone. Namatala river is the main inflow. The rivers draining the wetland discharge into the Mpologoma river system and ultimately Lake Kyoga. Two waste stabilization ponds (WSP) that receive wastewater from the Mbale town area (Namatala WSP and Doko WSP) discharge effluent into the wetland.

To create a better understanding of the wetland system, data on climate, hydrology, water quality, population and land use change in Namatala wetland was collected. Precipitation and temperature data (daily measurements from the climate station in Mbale town) for 2002–2010 and discharge and water level data (recorded at the gauging station at the main Namatala River along Mbale–Soroti road) for 2002–2010 were collected from the Directorate of Water Resources Management (DWRM). Water quality data for November 2008–February 2010 were obtained from the National Water and Sewerage Corporation (NWSC): total phosphorous (TP), ortho-phosphate (o-PO₄), and ammonium nitrogen (NH₄-N), all collected twice per month. Land use change was studied using land cover maps of 1990 and 2005 obtained from the National Forestry Authority (NFA). These were updated to the current situation using the GPS points collected during field surveys between January and November 2010. New maps for 1990, 2005 and 2011 were created using ArcGIS (Esri, Redlands, CA 92373-8100, USA).

2.2. Stakeholder and institutional analysis

Stakeholder analysis involved identifying all stakeholders likely to affect and be affected by decisions, and an analysis of stakeholder roles and interests, problems and interrelationships. The framework management plan of Doho-Namatala (WMD, 2008) and the socio-economic report for Namatala/Doko wetlands (WMD, 2007) were used to generate a first list of stakeholders and institutions. This list was completed after interviews with key informants: the Assistant-Commissioner (Wetland Management Department, WMD), the District Environment Officer, Mbale district and the Wetland Officer, Mbale Municipal Council.

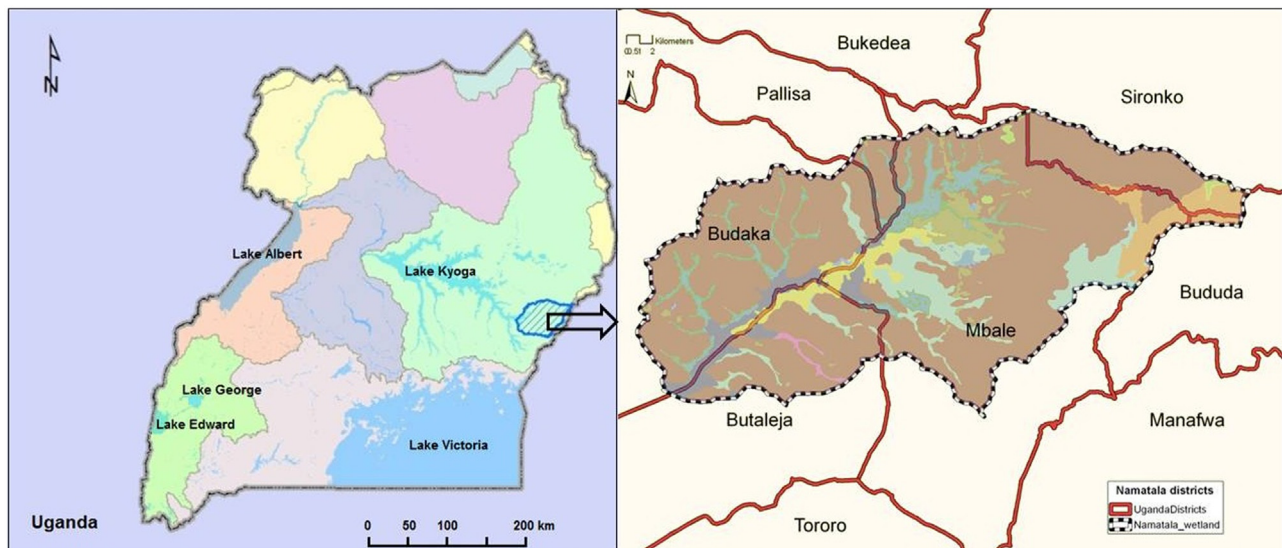


Fig. 1 – Map showing location and districts bordering Namatala wetland, Eastern Uganda.

Six stakeholder workshops were organized at community and national levels between June 2009 and November 2010. Local-level workshops were organized in Mbale town to bring together wetland resource user groups, district and sub-county management institutions, and civil society organizations. For each workshop the number of participants ranged from 25 to 30. National workshops were organized in Kampala and targeted officials from WMD, DWRM, Nile Basin Initiative (NBI), National Environment Management Authority (NEMA), Nature Uganda, National Agricultural Research Organization (NARO) and NWSC. The first workshop introduced the study and completed the stakeholder analysis process, identifying stakeholder roles, interests, interrelations and conflicts. During the second workshop, problems of the wetland site were analyzed. During the third workshop, these wetland issues were discussed and collected information was reviewed.

To assess the institutional set up, a review of existing policies and practices and of relevant documents and publications was conducted. This included the Policy for the Conservation and Management of Wetland Resources; the National Environment Act; The Wetland Sector Strategy Plan 2001–2010; The Water Act; The Land Act; and the Framework Management Plan of Namatala Wetland. An open-ended questionnaire designed in the WETwin project was used to collect information on institutional arrangements, stakeholder and public participation, adaptive capacity, the use of guidelines, wetland management planning and operational management of Namatala wetland. Informants included the Commissioner and Assistant Commissioner of WMD, Mbale District Environment and Wetland Officers, Sub-county Local Council Officers and representatives of rice farmers and papyrus harvesters.

2.3. Assessment of ecosystem services and wetland resources

A checklist of services was developed from existing wetland inventory reports and further developed through

group discussions during the stakeholder workshops. In addition, field observations and surveys were conducted from November 2009 to October 2010, guided by the NFA maps and the local community, to analyze the spatial distribution of services. Measurements of flow velocity, water level, and nitrogen and phosphorus concentrations were done twice per month during the period November 2009–October 2010.

A field survey of three days was done to delineate the wetland into hydrogeomorphic units (HGMUs) on the basis of soil characteristics, hydrological and geomorphologic landscape features (Maltby, 2009). This resulted in five HGMUs (Fig. 2):

- HGMU 1 located in the upstream parts of Namatala wetland and characterized by the main Namatala river channel and seasonally wet zones. Vegetation is composed of mainly shrubs: *Cassia spectabilis*, *Cassia singueana*, *Ipomoea wrightii*, and *Cassia obtusifolia*.
- HGMU 2, a floodplain characterized by the drainage streams originating south of Namatala wetland with seasonally wet zones. Vegetation is dominated by agricultural crops: rice, maize, sweet potatoes, sorghum; and shrubs: *Desmodium salicifolium*, *C. spectabilis*, *Pennisetum purpureum*.
- HGMU 3 forms the seasonally wet mid-floodplain. It is characterized by intensive agricultural drainage and rice fields. Shrubs grow on abandoned plots and include *Mimosa pigra*, *Solanum incanum*, *I. wrightii*, *D. salicifolium*, *Enhydra fluctuans*, and *Triumfetta macrophylla*.
- HGMU 4 forms the permanently wet mid-floodplain and is intensively drained for rice farming. Patches of *Cyperus papyrus* are found around the deeper waters of the main river channel. Other vegetation includes *Solanum mauritanum*, *Acanthus pubescens* and *Phytolacca dodecandra*.
- HGMU 5 is in the downstream part of Namatala wetland and is permanently wet. Natural vegetation includes *C. papyrus*, *Miscanthidium violaceum* and *Typha spp.*

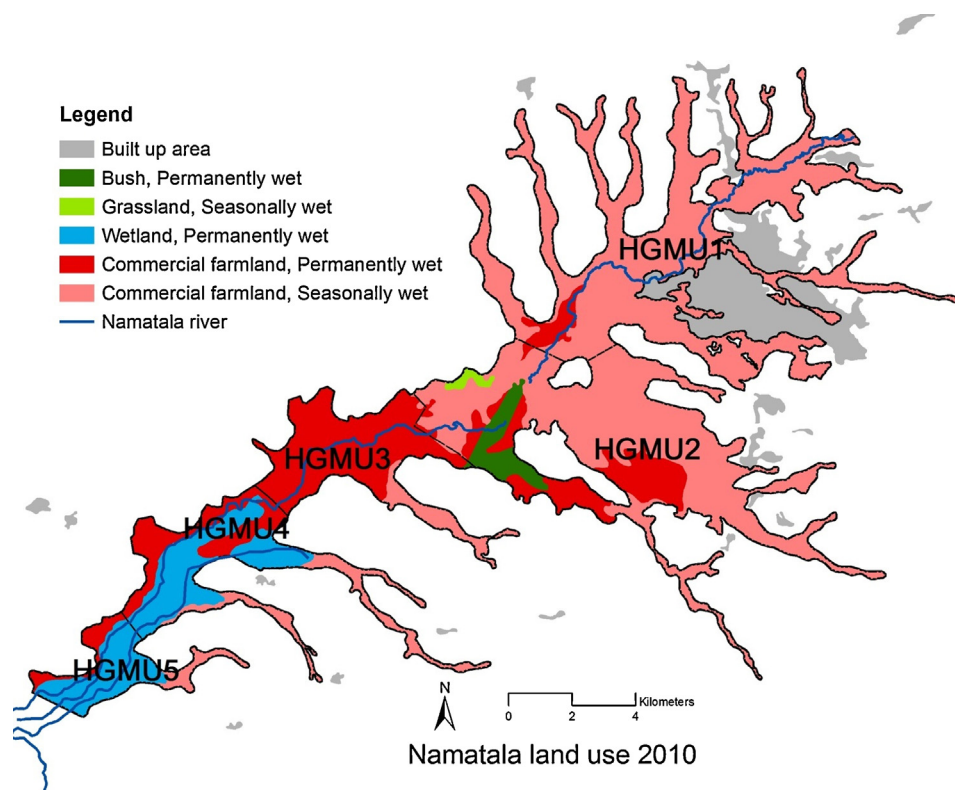


Fig. 2 – Map of Namatala wetland created on the basis of land use map, with outline of the hydrogeomorphic units (HGMUs).

Then, a questionnaire and checklist were used during a four-day field survey to record information about geo-morphic, hydrological (surface flow patterns, flow velocity, inundation, water levels) and ecological (vegetation types) indicators as well as climate, land use, soil management, tillage and farming practices. The WET-Ecoservices assessment tool (Kotze et al., 2009) was used to analyze 15 ecosystem services in each HGMU. Using field observations, each indicator for a given wetland service was scored from 0 to 4 and the score for each ecosystem service was determined as the average of the scores for the relevant characteristics. This was done for each HGMU separately (Fig. 6; see Supplementary material). As this was a first assessment of ecosystem services in Namatala wetland, the option to assign confidence scores was not used. Ecosystem services were classified as provisioning, regulating, habitat/supporting services, and cultural services (TEEB, 2010).

2.4. Analysis of wetland drivers, pressures and impacts on the ecosystem services

To analyze the drivers and pressures of ecosystem change, the most important problems in Namatala wetland were first defined. Open-ended questions were presented to stakeholder groups during the second stakeholder workshop (April 2010) to collect their views and perception of the major environmental problems in the wetland. These problems were presented during the workshop sessions to agree on categorization, and then tabulated and prioritized by the stakeholders using a scale of 1–5, where 1 represented the most urgent problem to be tackled.

The most urgent problems were further analyzed using the Driver-Pressure-State-Impact-Response (DPSIR) framework, following the typology developed by Wood and Van Halsema (2008). Drivers were identified as the broader economic, social and policy processes while Pressures were the more direct, physical influences on the wetland ecosystem. State changes were defined in terms of the components and processes of the wetland ecosystem (soil, water, vegetation and fauna) while Impact was defined as the consequences of these state changes on the associated final ecosystem services and goods (i.e., the socio-economic impact that is valued by people; see also conceptual framework in Mace et al., 2011). Stakeholders were asked to identify the drivers and pressures behind the problems as well as the state, impact and possible responses (actions or interventions) related to the problem. A combination of stakeholder opinions, data and literature were used to generate a causal network for the Namatala wetland using the enhanced DPSIR framework as described by Niemeijer and De Groot (2008). A more detailed household survey addressing resource use was done. Some initial results are used in this study but detailed survey results will be reported separately.

3. Results

3.1. Wetland characteristics

3.1.1. Climate

Precipitation results indicated high rainfall variability. During 2002–2010, highest rainfall was observed between April and

June and between September and November. Total annual rainfall showed a gradual decline over a period of eight years. Highest annual rainfall (639 mm) was recorded in 2003 and the lowest (298 mm) in 2010. Temperatures ranged between 15 and 28 °C, with highest temperatures between December and April. Rainfall variability influences the farming patterns of communities as they are forced to abandon the dry upland plots and settle in the wetland in search for reliable moisture to sustain the crops. In a household survey (Namaalwa, unpublished data) 16% of the respondents cited water availability as one of the reasons for wetland use.

3.1.2. Population

The population in the districts around Namatala wetland (Mbale, Butaleja, Budaka and Pallisa) is estimated at around 1.3 million people (UBOS, 2010). Mbale is the biggest among the four districts with a population of about 410,300 while the population of Butaleja, Budaka and Pallisa are estimated at 204,300, 293,600 and 394,100, respectively. Like in the rest of the Lake Kyoga catchment, these districts have recorded population growth of over 25% in a period of eight years. Population density ranges from 200 to 700 persons/km² against the country's average of 165 person/km² (UBOS, 2010). Population increase leads to increased demand for food and has stimulated wetland encroachment. In the household survey, 71% of respondents cite shortage of arable land as a reason for wetland use (Namaalwa, unpublished results).

3.1.3. Land use change

The land use categories in Namatala are bush, grasslands, wetlands and sedges, woodland, small-scale/subsistence farmland and commercial/large scale farmland. Small-scale farmland is defined as smallholder units with either monocropping or mixed cropping where crops are grown mainly for household consumption. Commercial farmland involves big units with monocropping where a crop is grown mainly for sale in the market (NBS, 2002). Land use in Namatala wetland has gradually changed in the last 20 years (Fig. 3). In 1990, small-scale farmland occupied the largest part of the wetland (44%), then expanded to 62% of the area in 2005 but is now reduced to less than 1%. Commercial farmland increased slowly initially to 12% in 2005 but by 2010 occupied 85% of the

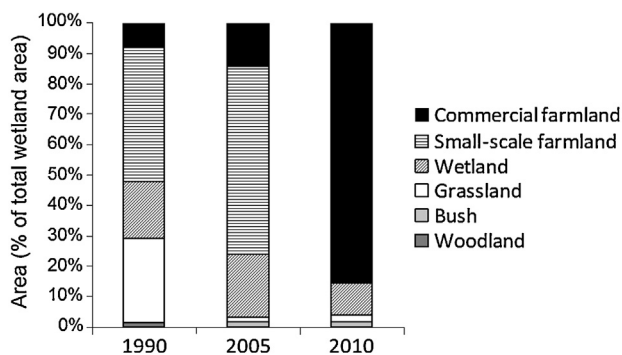


Fig. 3 – Land use change over time in Namatala wetland 1990–2005–2010.

Source: National Forestry Authority, 2005; field survey, 2010.

wetland. This rapid development of commercial farming was at the expense of grassland, which was reduced to 2% of the area in 2010, and wetland vegetation (papyrus and other sedges), which only occupied about 10% of the wetland in 2010 (Fig. 3).

The spatial distribution of land use change follows the hydrological gradient. Conversion from wetland to agriculture has gradually moved from upstream towards the downstream part of the wetland. Based on this gradient of hydrology and conversion, two distinct zones of Namatala wetland can now be distinguished: the upper Namatala wetland which has lost most of its natural vegetation and is almost completely converted to agriculture; and the lower Namatala wetland which is less degraded.

3.1.4. Hydrology and water quality

From the north, Namatala wetland is fed by the following rivers/streams: Namatala, Bote, Iki-iki, Katira, Sekulo, Nami-kisio, Nasenyi, Kawalumu, and Busajabwankuba. From the south, the tributary streams include Talisabagimba, Namakwekwe, Nabuyonga, Nashibisho, Wakhwaba, Nangarira, Ndukwe, Nasasa and Wantsira. Measurements of discharge in a number of these streams (Namaalwa, unpublished results) indicated that Namatala river is the major water input into the wetland, contributing about 70% of the total discharge. The average discharge for Namatala river ranges between 0.3 and 9 m³/s; and of the other tributaries between 0.01 and 0.6 m³/s. The maximum river discharges are recorded in April and May, corresponding to the peak rainfall events of the year (Fig. 4).

The urban centre of Mbale constitutes four surface water sources to the wetland: Namatala WSP effluent, Doko WSP effluent, and Budaka and Nashibisho streams. These surface drainage points of the urban centre form the point sources of mainly nitrogen, phosphorus, BOD and COD. The WSP systems are used by NWSC to treat domestic wastewater. Budaka and Nashibisho streams flow through Mbale town and receive pollution loads from the brewery industry and from other anthropogenic activities. The highest concentrations of TP and N-NH₄ for Namatala River (6 and 30 mg/L, respectively), Nashibisho and Budaka streams (around 6 and 40 mg/L, respectively) were recorded towards the end of the dry period in March.

3.2. Wetland stakeholder and institutional setting

3.2.1. Stakeholder characteristics

Table 1 and Fig. 5 show the stakeholders of Namatala wetland at different levels (local/wetland, sub-county & municipal, district and national levels). At the wetland level, stakeholders include rice farmers; other crop farmers who specialize in maize, millet, sweet potatoes and sugarcane; livestock keepers; fishers; alcohol distillers; fish farmers; sand and clay miners; firewood collectors; papyrus and grass harvesters; and the NWSC, Mbale branch. At sub-county and municipal level, stakeholders include the environment and wetland offices; environment committees; and the Departments of Community Services, Agriculture and Forestry. The setting at the district level involves the Environment Committee; Technical Planning Committee and the district departments of natural

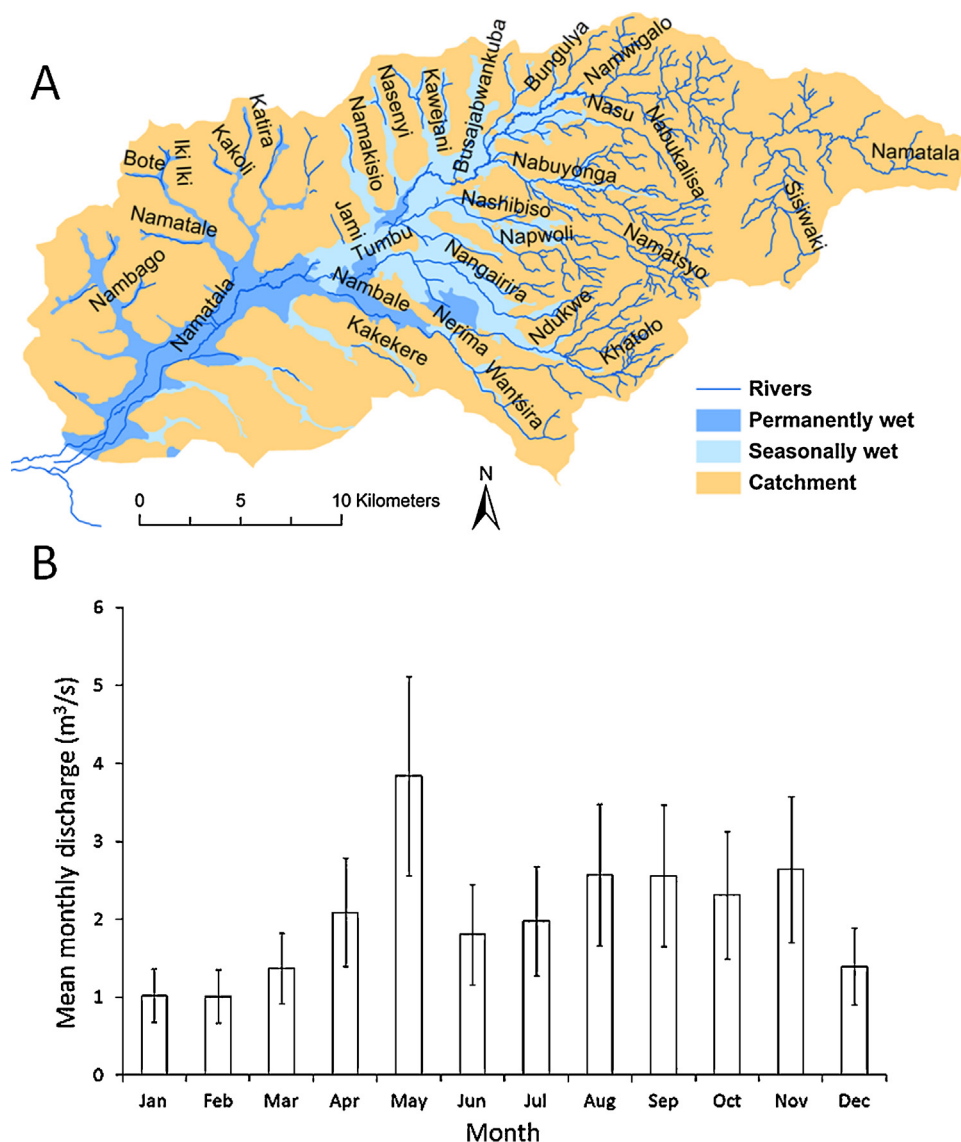


Fig. 4 – Rivers and streams that form Namatala wetland drainage (A), discharge of Namatala river year 2002–2010 (B).

resources management (DNRM), water, agriculture, forestry and community services.

The interests and roles in wetland use and management are diverse. Wetland communities are primarily interested in utilization of wetland resources while the management institutions at sub-county, district and national levels are more interested in conservation. The most important conflicts highlighted by the stakeholders were of two types: conflicts among the local resource users (farmers, livestock keepers, NWSC) mainly about the use of land; and conflicts between the organizations interested in conservation of the wetland and the community. As an example, a conflict was described between alcohol distillers, a housing project and the forest department about occupancy of the Namatala forest reserve by the alcohol distillers and the proposed extension of a housing development by the ADRA Housing Project.

The influence and importance of stakeholders in relation to development and implementation of the Namatala wetland management plan were assessed (see

Supplementary material). WMD, NEMA, NWSC, the District Councils and Environment Committees, and the District Environment and Wetland Departments have a high influence because of their legal mandate, their authority of leadership (Councils) and their established organizational structures. Their importance is also high mainly because of their strong negotiating position, control of strategic resources (including the budgeting and planning processes) as well as their expertise in management.

Many of the resource users (rice farmers, other crop farmers, papyrus harvesters, fishers, alcohol distillers, ADRA housing project) are characterized by high importance and low influence. These resource users are the targeted beneficiaries in wetland management; this, together with their customs and close interaction with the wetland, makes them very important for the successful implementation of management measures. On the other hand, they have a low influence because of their poor organization and weak community institutions.

Table 1 – Characteristics of stakeholders in Namatala wetland, Uganda.

Stakeholder group	Type ^a	Role/interest
<i>Community level</i>		
Rice farmers	P	Cultivating rice (main crop for income generation)
Sand and clay miners	P	Extraction of sand and clay (income generation)
Other crop farmers	P	Cultivating maize, millet, sugarcane, cassava, potatoes and cash crops (mainly for home consumption)
Papyrus and grass harvesters	P	Harvesting for home use and income generation from crafts
Fishers	P	Fishing (mainly mudfish and lungfish)
Fish farmers	P	Water and land for aquaculture farms
Livestock keepers	P	Forage resources
Alcohol distillers	P	Water use and discharge of wastes into wetland streams
ADRA housing project	P	Land for establishment of housing estates
National Water and Sewerage Corporation - Mbale branch	P	Provision of water and Sewerage services
Village local council	S	Conflict management
<i>Municipal/Sub-county level</i>		
Community-based services department	S	Awareness of communities on food security, health & income generation strategies
Sub-county environment committees	S	Compliance monitoring, sensitization awareness
Environment and wetland officers	S	Enforcement of policies & laws
<i>District level</i>		
District environment committee	S	Plan for wetland conservation and management activities, make ordinances, by-laws
Community based services department	S	Awareness of communities on food security, health & income generation
Environment department	S	Enforcement of policies & laws
Agriculture department	S	Advise farmers on good farming methods, interested in agricultural development
Forest department	S	Conservation and enhancement of forest resources
Water department	S	Provide water services, mobilize additional local resources for water and sanitation programmes
<i>National level</i>		
Wetlands management department	S	Lead agency for wetland management; Policy guidance; Technical backstopping of conservation activities
National Environment Management Authority	S	Coordination, monitoring, supervision and regulating environmental management
National Water and Sewerage Corporation	S	Provision of water and Sewerage services

^a P: primary stakeholder (intended beneficiaries of a project or those negatively affected); S: secondary stakeholder (groups or individuals who are intermediaries within a project e.g., funding, implementing, monitoring and advocacy organizations or governmental, NGO and private sector key individuals or informal groups).

Stakeholders characterized by low importance and high influence include the Local Councils I, II and III; and the District and Sub-county Departments of Agriculture, Forestry, Water and Community Services. These stakeholders have a low importance because they do not directly benefit from the wetland. However, they all participate in mobilization of user communities, facilitate implementation of strategic livelihood activities and have a strong linkage with wetland users, and therefore have a high influence since they can act as change agents.

3.2.2. Wetland management institutions and practices

The institutional framework for management of wetlands (Fig. 5, Table 2) comprises a number of institutions that participate directly and indirectly at the national, district and community levels. At the national level, the Ministry of Water and Environment (MWE) has a Directorate of Environmental Affairs (DEA), which includes the Wetlands Management Department (WMD), the lead technical agency responsible for managing wetlands, coordinating and regulating all sector activities and provision of support

services to the local governments. Another agency operating under MWE is the National Environment Management Authority (NEMA), a semi-autonomous agency responsible for the regulatory activities that focus on compliance and enforcement of the legal and institutional frameworks on environmental management.

In addition to the Ministry of Water and Environment, other line ministries play a role in wetland management: the Ministry of Local Government (MOLG), Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), Ministry of Finance Planning and Economic Development (MFPED), Ministry of Lands, Housing and Urban Development (MLHUD) and the Ministry of Tourism and Wildlife (MTW) through the Uganda Wildlife Authority (UWA). MOLG guides local governments on their operations and oversees the implementation of the decentralization policy. MFPED mobilizes and allocates funds to the sectors (including wetlands) and also reviews sector plans as a basis for allocation and release of funds. MAAIF spearheads agricultural development, including the on-farm use and management of water for production (irrigation, animal production and aquaculture). MLHUD is responsible

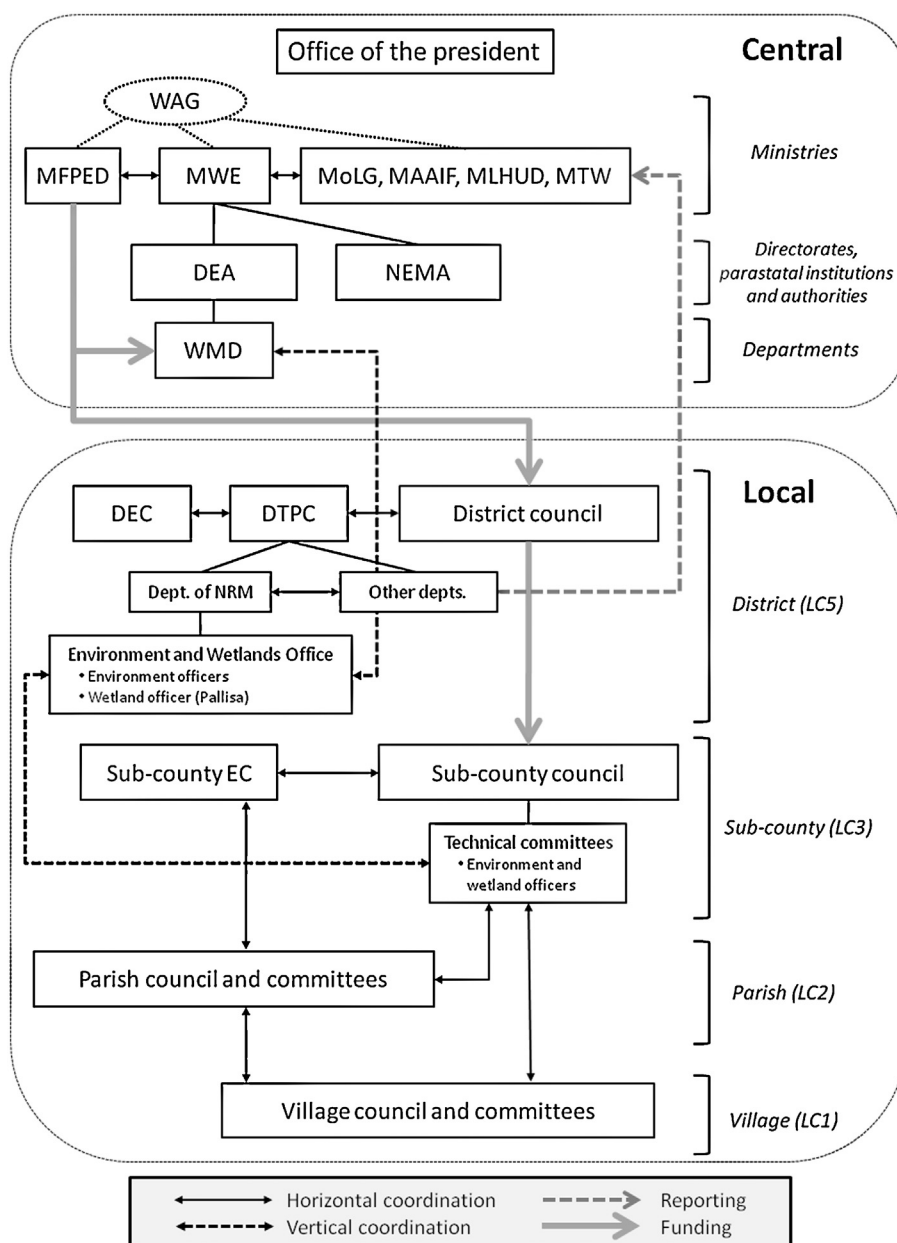


Fig. 5 – Institutional framework for management of Namatala wetland.

for the management of land affairs including physical planning, surveys and mapping, valuation, land registration, urban development and housing. UWA manages the forests in National Parks and Wildlife Reserves. Representatives of the line ministries form the Wetlands Advisory Group (WAG), which provides horizontal coordination of ministries and sectors and promotes wetland issues into other sectoral development plans.

Local government in Uganda is organized at five levels with local councils (LC 1–5) (see Mugabi, 2004 for a description of local government in Uganda). At the district level (LC 5), two categories of actors exist: the elected politicians who are the main decision makers on all matters pertaining to the district; and the technical departments who assist with technical guidance. The political arm has two organs: the District

Council and the sectoral committees. The latter includes the District Environment Committee (DEC) that coordinates the decisions of the District Council relating to environment, wetlands and natural resource management. The activities of the different technical departments (including Water, Community Services, Environment, Wetlands, Agriculture, Fisheries, and Forestry) are coordinated under the District Technical Planning Committee (DTPC). One of the technical departments is the Department of Natural Resources Management (DNRM), which includes the Environment and Wetlands Office responsible for environment and wetlands management at the district level. With exception of Pallisa district, other districts of Namatala wetland do not have fully appointed wetland officers. Instead, wetland management is assigned to one of the Environmental Officers in the

Table 2 – Institutional set up and management practices in Namatala wetland, by assessment criteria.

Assessment criteria	Indicator	Current status for Namatala wetland
<i>Institutional arrangement</i>	Relevant policies and legislation	National Wetlands Policy (1995) National Environment Management Act (1995) The Water Act (1997) The Land Act (1998) The Local Government Act (1997)
	Management bodies	Various sectoral ministries including the Ministry of Water and Environment
	Formal mechanism for cross-sectoral coordination	There is the presence of an Inter-Ministerial Steering committee to coordinate the various ministries at national level.
	Formal mechanism for vertical coordination	At district level there is the District Environment Committee and the District Technical Planning Committee. For implementation of the Namatala wetland Plan, Inter-district wetland management committee is established but not yet functional.
	Informal mechanisms	No clear mechanisms
<i>Stakeholder and public participation (PP)</i>	Formal mechanism for public participation	Public participation is made possible through the Sector Working Group, The Inter-ministerial Committee and the Environment and Natural Resources sector.
	Informal mechanisms (forum, platforms)	Some resource users' groups for wetland communities especially crop farmers.
<i>Financial and human resources</i>	Funding source (internal, external)	Government allocation and donors
	Funding	Insufficient budget
	Staff	Inadequate human capacity
<i>Adaptive capacity of existing structure</i>	Information availability	Limited knowledge base on wetland functioning and dynamics
	External network/expertise availability	Limited networks; data collection by UBOS, DWRM, NWSC, universities
	Flexibility (to change)	Not clearly stated
	Fund availability	Inadequate
<i>Use of guidelines</i>	Availability and use of guidelines at the national level	The National Wetlands Policy, The Paddy rice guidelines, Wetland edge gardening and fish farming.
	Availability and use of guidelines at the local level	Implementation not successful because guidelines do not adequately address the major problems.
	Stakeholders awareness about the guidelines	Little awareness
<i>Established planning procedures</i>	Formal procedure for planning at the national level	Established participatory procedure in place.
	Formal procedure for planning at the local level	There is a regular wetland management plan which involves the participation of various stakeholders e.g. the local community, district officials, sub county officials, civil society and NGOs.
<i>Operational management</i>	Formal procedure for operational management	The operational activities are based on the legal obligations of the institutions involved.
	Formal mechanism for PP in decision-making	Given in the management plan though not yet implemented.
	Impact of PP on decision-making	Stakeholders seem to have an impact on decision making but it is not entirely clear how.

Department. The Environment Office advises the sectoral committee on Environment and also coordinates with NEMA and WMD mainly for wetland monitoring and inspection activities.

At the sub-county level (LC 3), the institutional arrangement also includes political actors and technical staff. The political actors are organized into the Sub-county Council and Environment Committees. The Council is the decision-making arm of the sub-county and is responsible for

monitoring all sub-county activities including wetland management and sensitization of wetland users. The technical staff, including Environment and Wetland Officers, are organized into technical committees, which are the administrative and implementation organ for the Sub-county work plans. Together with the technical staff, the Council is also responsible for budgeting and planning. Apart from Mbale district which has a Municipal Wetlands Officer, other districts sharing the Namatala wetland system do not have

Environment and Wetland officers at sub-county level, hence wetland management issues are often part of the technical committees. The technical committees at the sub-county level work together with Village Council (LC 1) and Parish Council (LC 2) to prioritize wetland and other sector activities for inclusion in the sub-county work plans.

The institutional framework and linkages (horizontal and vertical interaction) were perceived to be unclear and weak by respondents at national, district and lower governance level. At the national level, horizontal interaction is hampered by lack of an effective coordination framework/platform, overlapping mandates among institutions and unclear roles and responsibilities. At the district and sub-county levels, horizontal interaction is mainly hampered by conflicting interests between political actors and technical staff hence influencing the decision making process. Vertical coordination is hampered by unclear institutional linkages between the central and local governments especially in terms of reporting structures. As an example, district environment and wetland

officers often submit technical and financial reports to MoFPED and MoLG, with no copies to WMD.

Wetland management is based on the existing national policies (see Table 2). The lower local governments depend on the same policies for the day-to-day management of the wetland. However, the existing policies have not been fully utilized to achieve the desired results. Adaptation of the national policies to the local context is a challenge as the policies do not adequately address the specific problems facing the wetland. On the other hand, there is a lack of awareness of the national guidelines among the local stakeholders.

In 2008, a framework management plan for Namatala wetland was developed through a participatory process involving stakeholders from districts sharing the wetland (WMD, 2008). The plan includes strategies for protection of the social, economic and environmental benefits of the wetland. However, the plan was never implemented. Some of the reasons cited include lack of integration with other sector

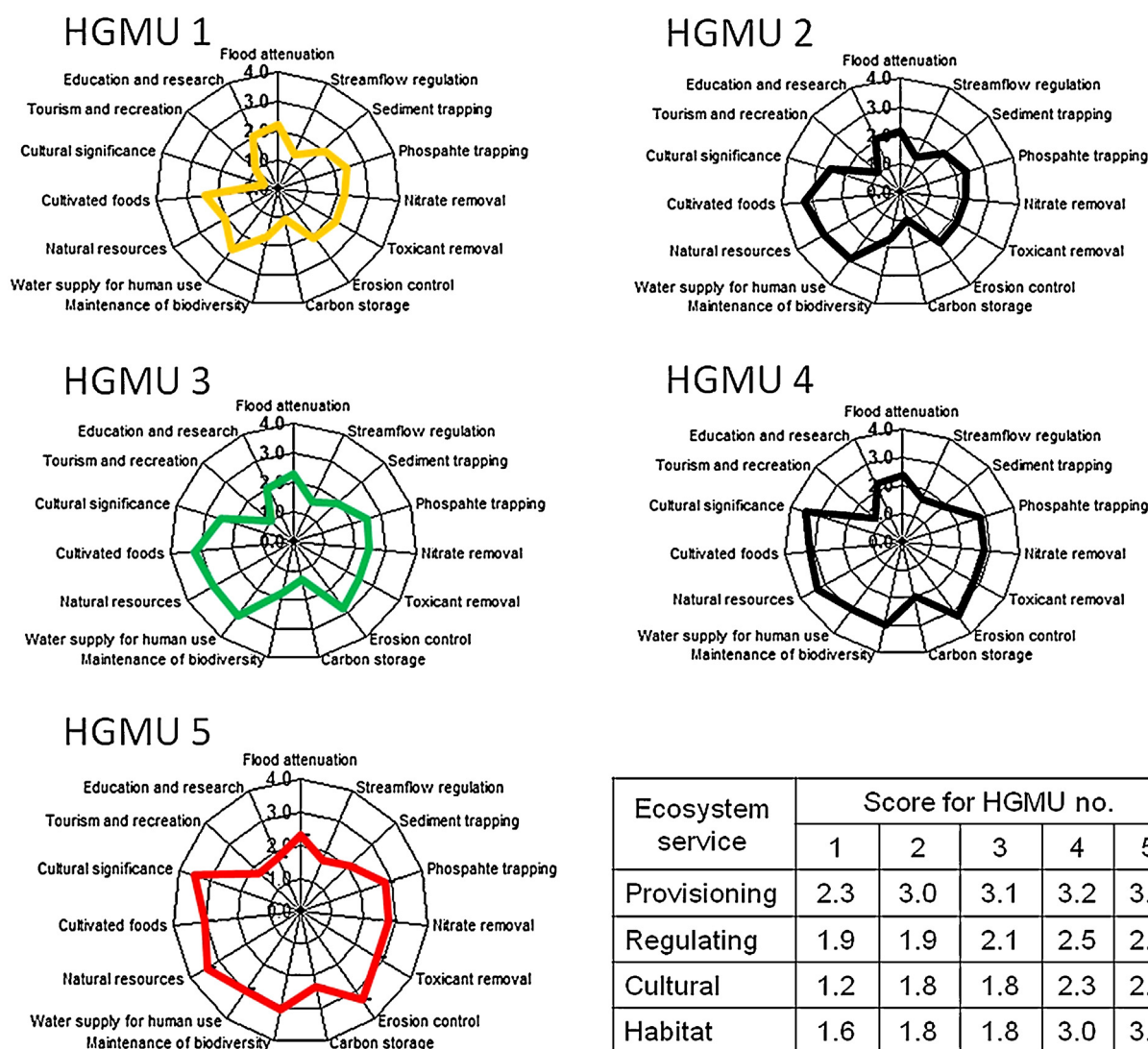


Fig. 6 – Ecosystem services scores in the five spatial HGM units of Namatala wetland, estimated using the WET Ecoservices method (Kotze et al., 2009).

Table 3 – Results of priority ranking (1: high-5: low) of wetland problems by different groups of stakeholders of Namatala wetland, Uganda. Priority ranking is based on the un-weighted average of the five scores, agreement ranking on coefficient of variation (lower score representing higher agreement on issues). Priority ranking based on the weighted average was identical to the ranking of the resource users due to their numerical majority.

Wetland problem	Ranking by					Priority ranking	Agreement ranking
	Resource users (87%)	Wetland institutions district (6%)	Wetland institutions national (3%)	Local council administrators (3%)	NGOs (1%)		
Agricultural encroachment	3	1	1	1	1	1	5
Loss of biodiversity	5	2	2	3	2	2	4
Wetland pollution	4	2	3	4	3	3	1
Conflicts in use and ownership	2	5	5	2	4	4	2
Diversion of streams and rivers	1	4	4	5	5	5	3

plans, insufficient stakeholder involvement especially at community level (direct wetland users), and limited human and financial capacity. Currently no wetland operational management tasks are taking place and the use of the wetland for agricultural activities goes on uncontrolled.

3.3. Ecosystem services provided by Namatala wetland

The ecosystem services of Namatala wetland include crop farming, fishing, livestock grazing, papyrus and grass harvesting, sand and clay mining, and transportation. Regulating

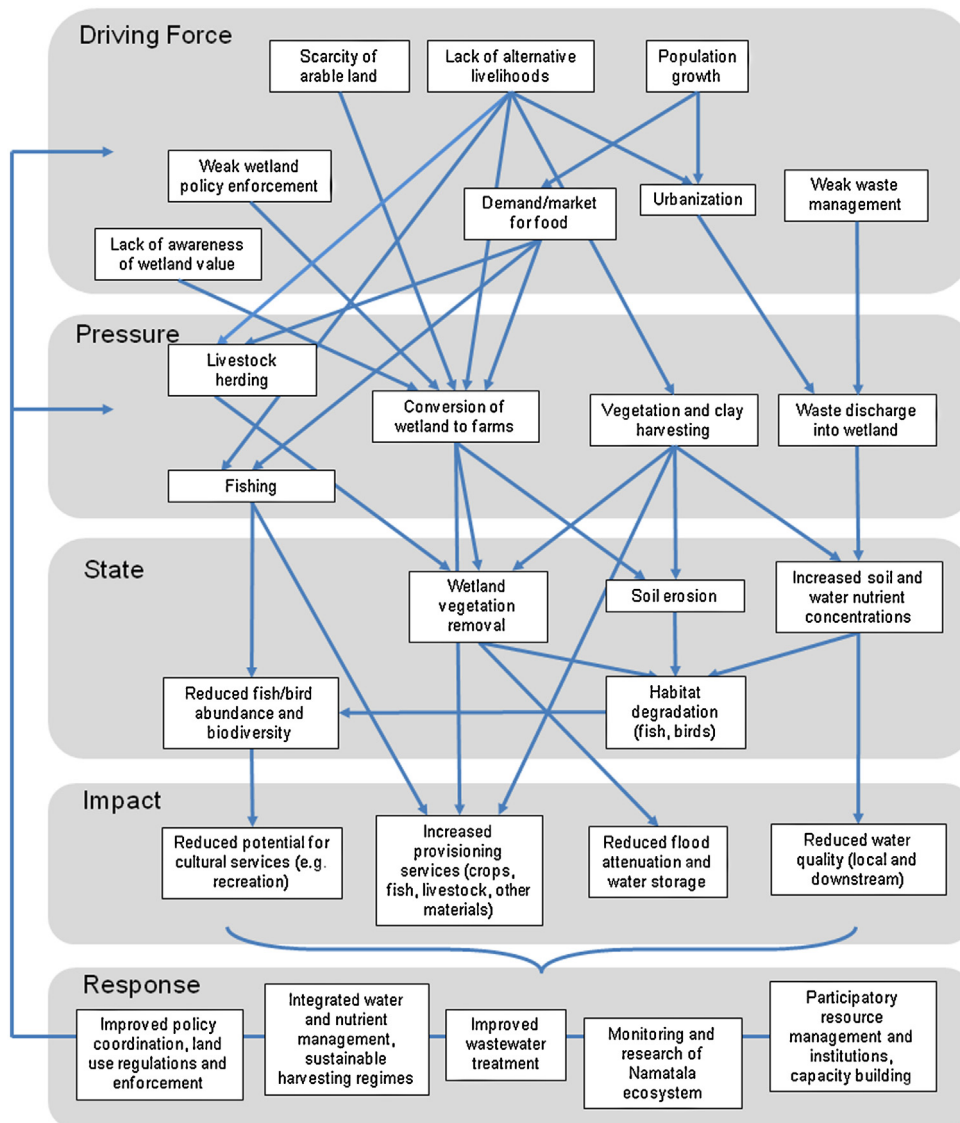


Fig. 7 – Enhanced-DPSIR analysis of Namatala Wetland, based on the method presented by Niemeijer and De Groot (2008).

services predicted by wetland characteristics included flood reduction, water storage, erosion control and nutrient reduction. Habitat services included habitat for natural plants such as *C. papyrus*, *Echinochloa* sp., *Miscanthus* sp., *Sorghastrum* sp., *Marantachloa* sp., *Phoenix reclinata*, *Hyparrhenia* sp., *Themeda* sp., *Cyperus rotundus*, *C. articulate*, *Eichornia crassipes*, *Azolla* sp., *Typha* sp., *Phragmites* sp., *Vossia* sp., *Ceratophyllum* sp., and *Polygonum salicifolium*.

Spatial analysis revealed differences in ecosystem services between the wetland units (Fig. 6). HGMU 1 scored moderately for the provisioning services with an average score of 2.3 against scores above 3 for the other HGMUs. For the regulating services, HGMUs 1 and 2 scored lower (both 1.9) than HGMUs 3–5 (2.1–2.5). All HGMUs scored rather low on cultural services with highest scores of 2.3 for HGMUs 4 and 5. For the habitat services, there was a clear difference between the low scores for HGMUs 1–3 (below 2) and the HGMUs 4 and 5 (both 3.0).

3.4. Wetland drivers, pressures and impacts on ecosystem services

Most stakeholder groups mentioned agricultural encroachment as the major issue of concern, giving it priority score 1 (see Table 3). Closely linked to agricultural encroachment was the issue of biodiversity loss, which most stakeholders explained as being caused by land use change and pollution due to agricultural encroachment. The resource users (farmers, papyrus harvesters, fishers) produced markedly different priority scores, with diversion of rivers and streams and land use and ownership conflicts as the most important problems. For them, wetland pollution and loss of biodiversity were lower priority problems.

For the DPSIR analysis, problems mentioned by stakeholders fell into different categories. E.g., agricultural encroachment is a pressure (P), whereas biodiversity loss is a change in state (S). Population growth, scarcity of arable land and the lack of alternative livelihoods were seen as important drivers of agricultural encroachment in Namatala wetland. The resulting demand for food, lack of awareness of wetland conservation and weak enforcement of Uganda's wetland policy lead to conversion of the wetland to farms. A parallel development is the growth of the urban centre of Mbale town, which, together with weak waste management, leads to increased waste discharge into the wetland. Livelihoods activities (primarily conversion to farming, but also livestock herding, fishing and vegetation harvesting) and waste discharge are thus the most important pressures on the wetland. These result in the following state changes: removal of the wetland vegetation, soil erosion, increasing nutrient concentrations in soil and water, habitat degradation and reduced biodiversity. The impact on ecosystem services is mixed: increasing nutrients and the livelihood activities have a positive effect on provisioning services (food, materials) but lead to reduced water quality, both for local use (e.g. drinking water) and for the downstream areas. This analysis is summarized in Fig. 7.

4. Discussion and conclusions

Namatala wetland provides a variety of ecosystem services, emphasizing the strong dependence of local communities and

other stakeholders on this wetland. There is a spatial gradient of ecosystem services in the wetland (Fig. 2). The upper Namatala wetland, which is characterized by agricultural land use, is important for food production but in the present state probably contributes less to the maintenance of biodiversity than before its conversion to agriculture. Due to the influence of tillage practices and channelization, the upper wetland scores low on regulating services such as sediment and nutrient trapping and stream flow regulation. In fact, the argument could be made that the provisioning services in the upper Namatala wetland are derived from the modification of the wetland to an agricultural system, and no longer result from a functioning wetland ecosystem. By contrast, the lower part of Namatala wetland which has less agriculture and more natural wetland vegetation is important for erosion control and maintenance of biodiversity, and supports livelihoods that are based on natural resources such as papyrus and fish. Analysis of the actual and potential pressures in the different HGMUs of Namatala wetland point the way to regulated use and the definition of potential trade-offs between the upper wetland which is under high pressure, and the less exploited lower wetland.

A further reduction or degradation of papyrus stands in the lower Namatala wetland by pollution, grazing, burning and harvesting is likely to lead to a reduction of biodiversity. Papyrus wetlands are key habitats for threatened (papyrus-) endemic bird species like the papyrus gonolek (*Laniarius mufumbiri*) and the papyrus yellow warbler (*Chloropeta gracilir-ostis*). These species are absent from highly disturbed areas whereas moderate use has no negative effect on habitat quality (Maclean et al., 2003, 2006). Papyrus also provides an important spawning habitat for indigenous fish like mudfish (*Clarias mossambicus*) and lungfish (*Protopterus aethiopicus*). Besides habitat loss due to agricultural encroachment, a main threat for indigenous fish is overexploitation by the fishery (Goudswaard et al., 2002; Aloo, 2003).

In addition to pollution and encroachment due to agriculture, pollution originating from the urban catchment of Mbale represents a rapidly growing pressure on the water quality regulation function of Namatala wetland. Apart from the effluent of the Doko and Namatala WSPs, several streams receiving untreated urban wastewater flow into the wetland. The abundance of flourishing small farms immediately downstream of the WSPs demonstrates the potential for recycling the nutrients in the wastewater but also raise concerns about human health risks. In this context it is interesting that many stakeholders confirm that no fertilizers are used in Namatala wetland. This suggests that crop production is supported by the nutrients entering the wetland from the catchment (including the WSPs). Farmers in the upper wetland complain, however, about deteriorating soil fertility. A continued increase in the load of nutrients, organic pollutants and micropollutants from human activities can be expected as the population in the catchment (including Mbale town) continues to grow. The limited data presented here on water quality in streams and river justify the need for more research into the nutrient dynamics and water quality regulation function of Namatala wetland and into options for integrated nutrient management.

The stakeholders of Namatala wetland exist at national, district and community level, resulting in a complex institutional framework. While wetland management is vested under the MWE, many of the other line ministries (MOLG, MPFED, MAAIF and MTTI/UWA) have a stake in wetland resources. Horizontal coordination of these line ministries is attempted through the inter-sectoral Wetlands Advisory group (WAG), but erratic implementation of development decisions among government agencies has been reported (Kaggwa et al., 2009). At the level of the districts and sub-counties sharing Namatala wetland, horizontal interaction is also weak. The technical staff in the department of environment and wetlands rely on the political arms of the districts and sub-counties for budgeting, planning and decision making.

Not only horizontal interaction, but also vertical coordination in wetland management faces challenges of limited funding, inadequate human capacity and weak local management institutions. Districts and sub-counties depend on national level ministries for funding of their activities, but lack of funding has hampered the implementation of the Namatala wetland management plan. At the same time, districts depend on WMD for technical backstopping and enforcement of wetland management policies, but these are limited by inadequate human resources. Participation of community wetland users is still weak due to lack of institutions for interaction. This leads to poor compliance with policies and a low level of local community participation in monitoring and regulation of encroachment.

Adding to the constraints in institutional linkages is the unclear situation with respect to wetland ownership. Although the 1995 constitution states that “wetlands . . . shall be held in trust by the government for the good of all people”, the majority of rural people in Namatala wetland hold land in customary ownership. This raises conflicts in regulation of wetland use as many wetland users avoid dialogue for fear of losing “their” land (IUCN, 2005). This is confirmed by the analysis of stakeholder conflicts (Table 3), which shows that considerable disagreement exists over the importance of agricultural encroachment and biodiversity loss between local resource users and government agencies.

Improvements in the management of Namatala wetland will need to come from (1) improved horizontal policy coordination at national level between various ministries dealing with wetland issues; and improved vertical coordination between national and local government levels. The decentralized set up of governance in Uganda presents both opportunities and challenges. Effective implementation of the national policy framework requires strong linkages and coordination with local government institutions (including adequate funding, capacity building and participation of resource users); (2) participatory natural resources management and development of relevant institutions where rights and responsibilities of local resource users and other agents are clearly defined and agreed. Building capacity among stakeholders should be part of this effort. Examples of these approaches are known from forest management (e.g. Lynam et al., 2007) and wetlands (e.g. Ramsar Convention Secretariat, 2010); (3) application of advanced methods for sustainable

agriculture and integrated water and nutrient management. The discharge of wastewater from the urban area of Mbale into Namatala wetland provides an opportunity for recycling nutrients and preventing their release into the areas downstream of Namatala wetland towards Lake Kyoga, but also presents the risk of contamination with chemical and bacterial pollutants. Sustainable management can be achieved through a combination of improved waste treatment strategies and recycling of nutrients through agriculture; (4) continued monitoring of the Namatala wetland ecosystem and research into the trade-offs between provisioning and regulating ecosystem services. The assessment of ecosystem services in each HGMU in the present study was qualitative; a more quantitative assessment is needed. While a complete restoration of the upper part of the wetland seems unlikely, there is potential for a balanced and sustainable combination of food production in the upper wetland with nutrient and sediment retention and biodiversity in the lower Namatala wetland. For this combination to be successful, adaptive management is needed with awareness among all stakeholders of the importance of all ecosystem services of Namatala wetland.

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REFERENCES

- Aloo, P.A., 2003. Biological diversity of the Yala Swamp lakes, with special emphasis on fish species composition, in relation to changes in the Lake Victoria Basin (Kenya): threats and conservation measures. *Biodiversity and Conservation* 12, 905–920.
- Bakema, R.J., Iyango, L., 2001. Engaging Local Users in the Management of Wetland Resources: the Case of the National Wetlands Programme, Uganda. IUCN Eastern Africa Regional Office, Nairobi.
- Goudswaard, P.C., Witte, F., Chapman, L.J., 2002. Decline of the African lungfish (*Protopterus aethiopicus*) in lake Victoria (East Africa). *African Journal of Ecology* 40, 42–52.
- Hartter, J., Southworth, J., 2009. Dwindling resources and fragmentation of landscapes around parks: wetlands and forest fragments around Kibale National Park, Uganda. *Landscape Ecology* 24, 643–656.
- IUCN, 2005. From conversion to conservation: 15 years of managing wetlands for people and the environment in Uganda. WID, Kampala, Uganda and IUCN Eastern Africa Regional Programme, Nairobi, Kenya.
- Kaggwa, R., Hogan, R., Hall, B., 2009. Enhancing Wetlands' Contribution to Growth, Employment and Prosperity. UNDP/NEMA/UNEP Poverty Environment Initiative, Kampala, Uganda.

- Kotze, D.C., Marneweck, G.C., Batchelor, A.L., Lindley, D.S., Collins, N.B., 2009. WET EcoServices. A technique for rapidly assessing ecosystem services supplied by wetlands. Water Research Commission report TT 339/09, Pretoria.
- Lynam, T., de Jong, W., Sheil, D., Kusumanto, T., Evans, K., 2007. A review of tools for incorporating community knowledge, preferences, and values into decision making in natural resources management. *Ecology and Society* 12 (1), 5., <http://www.ecologyandsociety.org/vol12/iss1/art5/>.
- Mace, G.M., Bateman, I., Albon, S., Balmford, A., Brown, C., Church, A., Haines-Young, R., Pretty, J.N., Turner, K., Vira, B., Winn, J., 2011. Conceptual Framework and Methodology. In: The UK National Ecosystem Assessment Technical Report. UK National Ecosystem Assessment, UNEP-WCMC, Cambridge.
- Maclean, I.M.D., Hassall, M., Boar, R.R., Nasirwa, O., 2003. Effects of habitat degradation on avian guilds in east African papyrus *Cyperus papyrus* L. swamps. *Bird Conservation International* 13, 283–297.
- Maclean, I.M.D., Hassall, M., Boar, R.R., Lake, I.R., 2006. Effects of disturbance and habitat loss on papyrus-dwelling passerines. *Biological Conservation* 131, 349–358.
- Maltby, E. (Ed.), 2009. Functional Assessment of Wetlands. Towards Evaluation of Ecosystem Services. Woodhead Publishing Limited, Oxford.
- MEA, 2005. Ecosystems and Human Well-being: Wetlands and Water Synthesis. Millennium Ecosystem Assessment. World Resources Institute, Washington, DC.
- Mugabi, E., 2004. Uganda's decentralisation policy, legal framework, local government structure and service delivery. In: First Conference of Regional Assemblies of Africa and Europe, Regional Assembly of Tuscany and United Nations Department of Economic and Social Affairs (UNDESA), 17–18 September, Florence, Italy, <http://unpan1.un.org/intradoc/groups/public/documents/UN/UNPAN031014.pdf>.
- NBS, 2002. National Biomass Study Report 1996–2002. National Biomass Study Project, Forestry Department, Kampala.
- NEMA, 2006/2007. State of Environment Report for Uganda. National Environment Management Authority, Kampala, Uganda, p. 332.
- Niemeijer, D., De Groot, R.S., 2008. Framing environmental indicators: moving from causal chains to causal networks. *Environment, Development and Sustainability* 10, 89–106.
- Ramsar Convention Secretariat, 2010. Participatory skills: establishing and strengthening local communities' and indigenous people's participation in the management of wetlands, Ramsar Handbooks for the Wise Use of Wetlands, 4th ed., vol. 7. Ramsar Convention Secretariat, Gland, Switzerland.
- TEEB, 2010. The Economics of Ecosystems and Biodiversity for Local and Regional Policy Makers. TEEB project document.
- UBOS, 2010. Statistical Abstract. Uganda Bureau of Statistics, Government of Uganda, Kampala.
- van Dam, A.A., Kipkemboi, J., Zaal, A.M., Okeyo-Owuor, J.B., 2011. The ecology of livelihoods in East African papyrus wetlands (ECOLIVE). *Reviews in Environmental Science and Biotechnology* 10, 291–300, <http://dx.doi.org/10.1007/s11157-011-9255-6>.
- WMD, 2007. Socio-economic baseline survey carried out among local communities adjacent to the Okole/Arocha, Namatala/Doho, Rwizi/Rufuuha and Sezibwa wetland systems for the Wetland Sector Strategic Plan. Wetlands Management Department Support Project (WSSP-SP), Wetlands Management Department, Ministry of Water and Environment, Kampala, Uganda.
- WMD, 2008. Framework management plan for Doho-Namatala wetland system. Wetlands Management Department Support Project (WSSP-SP), Wetlands Management Department, Ministry of Water and Environment, Kampala, Uganda.
- WMD/MWE/UBOS/ILRI/WRI, 2009. Mapping a Better Future: How Spatial Analysis Can Benefit Wetlands and Reduce Poverty in Uganda. Wetlands Management Department, Ministry of Water and Environment, Uganda; Uganda Bureau of Statistics; International Livestock Research Institute; World Resources Institute, Washington, DC.
- Wood, A., van Halsema, G.E., 2008. Scoping agriculture-wetland interactions: towards a sustainable multiple-response strategy. *FAO Water Report 33*, Food and Agriculture Organization of the United Nations, Rome, Italy.
- Wood, A.P., 2003. Sustainable wetland use, food security and river flow: some experiences from the highlands of Ethiopia and Rwanda. *Revue de Geographie Alpine* 91, 57–68.
- Zsuffa, I., Cools, J., Vlieghe, P., Debels, P., van Griensven, A., van Dam, A., Hein, T., Hattermann, F., Masiyandima, M., Cornejo, R., de Grunauer, M.P., Kaggwa, R., Baker, C., 2008. The WETwin project: enhancing the role of wetlands in integrated water resources management for twinned river basins in EU, Africa and South-America in support of EU Water Initiatives. In: Paper presented at the 11th IWA Conference on Watershed and River Basin Management, Budapest, 4–5 September, http://www.wetwin.net/downloads/paper_IWA2008_zsuffa.pdf.